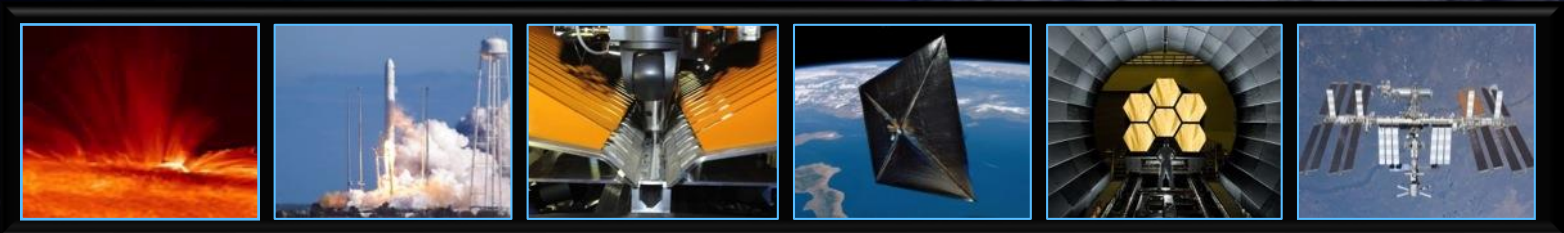




# Promoting a Culture of Tailoring for Systems Engineering Policy Expectations

*Van A. Blankenship*  
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*NASA/Marshall Space Flight Center*



## ◆ **Background**

- MSFC legacy of successful missions
- Lifecycle variations based on primary mission areas

## ◆ **Integrate and Streamline Policy Expectations**

- “One-Stop-Shop” for programs and projects
- Integrated set of reviews and technical product expectations

## ◆ **Transition Culture from Compliance to Tailoring**

- Risk-averse approach vs. risk-informed decision-making
- Streamlined process to assess compliance and approve tailoring

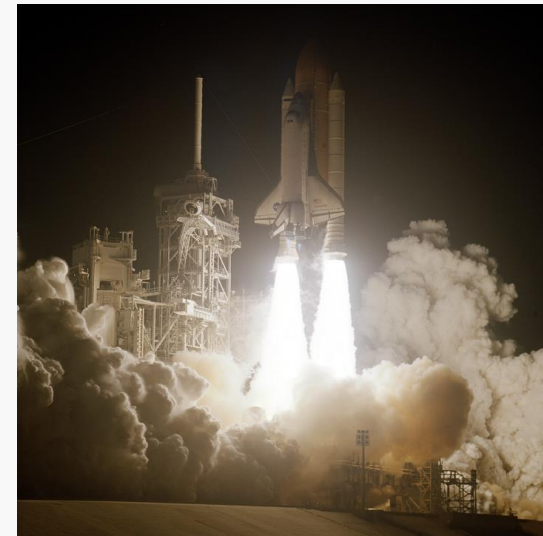
## ◆ **Consistent Methodology to Scale Policy Expectations**

- Classify projects using standard scaling factors
- Mission type classification scheme and how it is used in tailoring policy

## ◆ **Implementation Tools to Enhance Understanding and Promote Tailoring**

- MSFC Customization Tool
- Example of customization approach for a small MSFC project
- Example of compliance assessment for a small MSFC project

## ◆ **Conclusions**



## ◆ **MSFC Legacy of Mission Success across Diverse Technical Areas**

- Launch vehicles and space transportation systems
- Propulsion systems
- Space systems
- Scientific research

## ◆ **Program/Project Lifecycle Variations for Primary Mission Areas**

- Spaceflight systems for human or robotic exploration/operations
- Space technology development
- Scientific research

## ◆ **Policy had become Complex and Difficult to Implement**

- Requirements, expectations, and guidance located in various documents
- Ambiguity regarding the associated level of technical rigor expected/needed

## ◆ **Each Program/Project Invested Significant Time and Effort**

- Navigate, understand, and integrate the expectations
- Determining intended applicability and value added for each particular project
- Determining what could be tailored and approval process

# Integrate and Streamline Policy Expectations



## ◆ **Flow Down of Top-Level Expectations into Center Policy**

- Integrated “one-stop-shop” for programs and projects
- Addresses all of MSFC’s primary mission areas:
  - Spaceflight, technology development, and scientific research
- Single source to understand everything required to meet stakeholder expectations
- Incorporating over 50 years of lessons learned experiences

## ◆ **Provides an Integrated Set of Requirements for Each Lifecycle Type**

- Technical and programmatic reviews throughout the project lifecycle
- Integrated set of technical and programmatic products for each review
- Product maturity expectations for each review

## ◆ **Establishes a Minimum Level of Rigor in Technical Execution**

- Agency and industry standards
- Lesson’s learned from MSFC’s prior project experience
- Specific direction from MSFC’s governing authority

## ◆ **Each Program/Project Assesses Against**

- Standard suite of systems engineering processes and lifecycle reviews
- Determines applicability for their particular project case

# “One-Stop-Shop” for Programs and Projects



## Policy Requirements Flow-Down at MSFC

NPR-8000 Series  
Flight Safety and  
Mission  
Assurance

HQ

NPR-7123.1  
Systems  
Engineering

NPR-7120.5  
Space Flight P/P  
Management

NPR-7150.2  
Software  
Engineering

NPD-7120.6  
Knowledge  
Policy on P/P

NPR-7120.7  
IT & Institutional  
P/P Management

NPR-7120.8  
R&T P/P  
Management

NPR-7120.9  
PDLM  
Management

NPR-7120.10  
Technical  
Standards

MSFC

MPR 7120.1 integrates all of the above NPRs

Program/Project  
Documentation

PROG-PL-001  
Program/Project  
Plan

MPR 7120.1

MSFC  
Engineering and  
Program/Project  
Management  
Requirements

MPR 7123.1

MSFC System  
Engineering  
Processes and  
Requirements

MPR 7150.1

MSFC Software  
Engineering  
Requirements

MPR 1280.10

Marshall  
Quality  
Management  
System

Horizontal and vertical integration are  
key.

Handbooks, Guidance, Best Practices

MSFC-HDBK-3173  
PM & SE Handbook

MSFC-HDBK-3684  
Program, Planning, &  
Control Handbook

MGM 8040.1  
CM Guide

MGM 7120.3  
DM Guide

MSFC  
Guidance



# Change the Culture from an Emphasis on Compliance to Tailoring



## ◆ Compliance Culture

- Ensure mission success; minimize risk of failure
- Rigorous application of prescribed requirements and methods
- Risk-averse approach in which policy is seen as rigid, and tailoring is not typically employed

## ◆ Tailoring Culture

- Enable mission success, balancing cost against tolerance for failure
- More flexible and efficient approach for a discerning and creative culture
- Utilizes risk-informed decision-making, taking into account:
  - Each program/project's particular mission and programmatic characteristics
  - Intended application of the policy requirements

## ◆ Streamlined Process to Assess Compliance and Approve Tailoring

- Single integrated matrix to assess compliance, evaluate implementation approaches, document rationale, and approve tailoring requests through the MSFC governance bodies
- Simplified process for tailoring approval and associated record keeping
- Requesting and approving tailoring becomes an normal part of the project planning process

# Consistent Methodology to Scale Policy Expectations



## ◆ **Classify Projects Using Standard Scaling Factors**

- Mission criticality/significance
- Tolerance for failure
- Complexity
- Investment cost
- Expected lifetime
- Primary mission areas supported

## ◆ **Mission Type Classification Scheme is Used to Determine:**

- Applicability of requirements and technical/programmatic products
- Recommend and evaluate customized implementation approaches based on lessons learned and past project history
- Determine the need and develop rationale for tailoring of selected requirements, reviews, and products
  - Based on each project's specific risk tolerance and mission characteristics
- Enable risk-informed decision-making by MSFC governance bodies

# Project and Activity Categorization Table



Project and Activity Categorization/Mission Types								
	Projects						Activities	
	Type 1	Type 2		Type 3			Type 4	Type 5
		2.a	2.b	3.a	3.b	3.c		
<b>Cost Guidance (Estimated LCC)</b>	greater than \$1B	\$1B - \$250M	\$250M - \$100M	\$100M - \$50M	\$50M - \$10M	less than \$10M	typically <sup>1</sup> greater than \$1M/yr or greater than \$10M LCC	typically <sup>1</sup> less than \$1M/yr or less than \$10M LCC
<b>Priority (Criticality to Agency Strategic Plan)</b>	Any	Any	High	Medium or low priority	Low priority	Low to very low priority	High to Agency or Center	Medium or Low
<b>Other Factors</b>	Significant Radioactive Material							
<b>Decision Authority</b>	NASA Associate Administrator	NASA Mission Directorate Associate Administrator		NASA Mission Directorate Associate Administrator or Designee			Center Director or Designee	Directorate/Office Manager or Designee
<b>Governing PMC</b>	Agency	Mission Directorate		Mission Directorate			CMC	Monthly Program Reviews Within Directorate/Office
<b>National Significance</b>	Very high	High	Medium	Medium	Low	Very Low		
<b>Risk Tolerance</b>	Class A Risk: Very low (minimized)	Class B Risk: Low	Class C Risk: Medium	Class D Risk: High	Class D Risk: High	Class D Risk: High		
<b>Description of the Types of Mission</b>	Human Space Flight or very large Science/Robotic Missions	Non-Human Space Flight or Science/Robotic Missions	Small Science (Human or Non human)	Smaller Science (Human or Non human)	Science (Human or non human)	Science (Human or non human)	Efforts supporting program/projects managed outside of MSFC, that come under the purview of the CMC per the criteria defined in MPR 7120.4	Efforts supporting program/project managed outside of MSFC, that do not come under the purview of the CMC per the criteria defined in MPR 7120.4
<b>Complexity</b>	Very high to high	High to Medium	Medium to Low	Low	Low	Low to Very Low		
<b>Mission Lifetime (Primary Baseline Mission)</b>	Long (>5 years)	Medium (2-5 years)	Short (<2 years)	Short (<2 years)	Short (<2 years)	Short (<2 years)		
<b>Launch Constraints</b>	Critical	Medium	Few to none	Few to none	Few to none	None		
<b>Achievement of Mission Success Criteria</b>	All practical measures are taken to achieve minimum risk to mission success. The highest assurance	Stringent assurance standards with only minor compromises in application to maintain a low risk to mission success.	Medium or significant risk of not achieving mission success is permitted. Minimal assurance standards are permitted.	Significant risk of not achieving mission success is permitted. Minimal assurance standards are permitted.	Significant risk of not achieving mission success is permitted. Minimal assurance standards are permitted.	Significant risk of not achieving mission success is permitted. Minimal assurance standards are permitted.		
<b>Examples</b>	HST, Chandra, Cassini, JIMO, JWST, MPCV, SLS, ISS	MER, MRO, Discovery payloads, ISS Facility Class payloads, Attached ISS payloads	ESSP, Explorer payloads, MIDES, ISS complex sub rack payloads, PA-1, ARES 1-X, MEDLI	SPARTAN, GAS Can, technology demonstrators, simple ISS, express middeck and sub rack payloads, SMEX, MISSE-X, EV-2	IRVE-2, IRVE-3, HFIRE, HyBoLT, ALHAT Earth Venture I, FASTSAT	DAWNair, InFlame, Research, technology demonstrations, HEROES, SWORDS Payloads, Nanosails	ADDITIVE Manufacturing in Space	MSFC activities in support of a request from program/project outside of MSFC, for MSFC supporting activities. Subject to requesting organization's requirements.



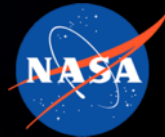
# Implementation Tool to Enhance Understanding and Promote Tailoring



## ◆ MSFC Customization Tool

- Integrated, automated, interactive spreadsheet
- Helps projects understand, manage, and implement policy expectations
- Accounts for project's particular lifecycle and mission type characteristics
- Automatically filters information to show customized view for each project
  - Applicable requirements, products, and lifecycle review expectations
  - Recommended customized implementation approach for selected products/reviews
  - Recommended tailoring for selected products/reviews
- Integrated matrix to document project's chosen approach and any tailoring needed
- Single matrix to facilitate the process for documenting associated rationale and obtaining necessary approval of governing authorities
- An integrated, automated, interactive spreadsheet
  - Microsoft Excel with a Visual Basic for Applications software component
  - Currently exploring the potential to evolve to a more powerful platform
  - Model policy within an integrated model-based systems engineering environment

# Example of Customization Approach



Life Cycle Type	Products Black text = Agency required, Red text = Agency guidance Green text = MSFC (added) required, Blue text = MSFC (added) guidance	Type 3.c	Type 4	Additional guidelines/comments	Actual Customization		
		Manned Flight	Manned Flight		Implemented as recommended	Modified	N/A
							Comments
TD Project	11. Verification and Validation Report	Project Plan Appendix	Activity Plan Appendix	Required. Document in form suitable for technical review.	X		Final report after all V&V activities and before FU delivery
TD Project	12. Operations Handbook, if applicable			Required	X		Flight operations prepared by MSG for ISS crew
TD Project	13. Orbital Debris Assessment per NPR 8715.6 <sup>5</sup>	NA	NA	Required for LEO. Document in form suitable for technical review.		X	Mission operates inside ISS
TD Project	14. End of Mission Plans per NPR 8715.6/NASA-STD	Project Plan	Activity Plan	Required. May be combined with other plans.		X	The Printer will be brought back and retained by NASA
TD Project	15. Mission Report (Final Report from Closeout Review)			Required	X		Final report will be completed at end of mission
TD Project	2. TD Project Plan		Activity Plan	Required		X	The Activity Plan will be called a Project Plan and tailored for a Type 4
TD Project	Systems Engineering Applicability Assessment (EMC approved)			Required	X		Systems Engineering matrix to show compliance is complete
TD Project	Technical Review Applicability Assessment (CMC approved)			Required		X	Per approval of CMC, each review will have individual Review Plan
TD Project	Plans for work to be accomplished during next Implementation life cycle phase	Included in Review Data	Included in Review Data	Required. May be documented in the form of review presentation material.		X	Action list will be kept to follow forward actions to complete work
TD Project	Documentation of performance against plans for work to be accomplished during next implementation phase, including performance against baselines and status/closure of formal actions from previous KDP	Included in Review Data	Included in Review Data	Required. May be documented in the form of review presentation material.		X	RFA's will be closed out at each new review (KDP) and actions for next phase kept on an Action item list
TD Project	1. Technical, Schedule, and Cost Control Plan	Project Plan	Activity Plan	Required. May be combined with other plans.	X		Project Plan, Sections 2.4 and 3.1
TD Project	4. Acquisition Plan	Project Plan	Activity Plan	Required. May be combined with other plans.		X	Contract to MIS
TD Project	6. Systems Engineering Management Plan (may be combined with TD Project Plan)	Project Plan	Activity Plan	Required. May be combined with other plans.	X		Project Plan, Section 3.6

## ◆ “3D Printing in Zero-G”

- Small technology demonstration project
- International Space Station in the Microgravity Science Glovebox (MSG)
- Demonstration of additive manufacturing technology in microgravity
- Mission Type 4 Activity
- Relatively low cost but high visibility for the Agency and MSFC
- Relatively high acceptable tolerance to risk of failure

# Example of Compliance Assessment



NPR # and Section	MPR 7120.1 Section	MPR 7120.1 Requirement Statement	Approvals Required for Tailoring	Program/Project Compliance			Approval Signatures for Tailoring
				Program/Project Documentation	Comply? (Full, Tailored, or NA)	Rationale for Decisions, Comments, Waiver/Deviations	
MSFC Derived	28.3	Type 4 and 5 activities shall report the results of the Activity Agreement and Activity Plan to the Director of the MSFC office responsible for managing the activity and to the Engineering Director. The Directors may choose to impose additional project management requirements as determined appropriate based on the particular characteristics of that activity.	CD	MaGIXS Activity Plan, MPR 7120.1 Compliance Matrix Appendix	Full		
MSFC Derived	28.4	Type 4 activities shall also report the results of the Activity Agreement and Activity Plan to the Associate Director, Technical and the Center Director, who may choose to impose additional project management requirements as determined appropriate based on the particular characteristics of that activity.	CD	MaGIXS Activity Plan	N/A	MAGIXS is categorized as a Mission Type 5 Activity per guidance provided in MPR 7120.1, Table 3-1.	
MSFC Derived	28.5	Type 4 and 5 activities shall determine applicability of the following recommended technical reviews, as described in MPR 7123.1. The recommended technical reviews are SRR, PDR, CDR, Design Certification Review (DCR)/ System Acceptance Review (SAR) or Pre-Ship Review, and FRR. Category 4 and 5 activities may customize the entrance/exit/success criteria and degree of formality of the reviews, or combine reviews; provided that they include the minimum data content necessary to accomplish the objectives of each review and satisfy the success criteria that is applicable for that particular activity, as indicated in MPR 7123.1.	CD	MaGIXS Activity Plan	Full		
MSFC Derived	28.6	Type 4 and 5 activities shall assess the seventeen systems engineering processes, as described in MPR 7123.1, to determine applicability of each process for their particular activity, and complete the MPR 7123.1 compliance matrix for those that are determined applicable.	CD	MaGIXS Activity Plan, MPR 7123.1 Compliance Matrix Appendix	Full		
MSFC Derived	28.7	Type 4 and 5 activities shall report the results of the Technical Review and Systems Engineering Applicability Assessments to the Director, Engineering Directorate, for approval and follow the requirements in MPR 7123.1 for those processes determined applicable by the Engineering Director. The Engineering Director may choose to impose additional systems engineering requirements as determined appropriate based on the particular characteristics of that activity.	CD	MaGIXS Activity Plan, MPR 7123.1 Compliance Matrix Appendix	Full	Presentation to the Director, Engineering Directorate (EMC) on the System Engineering Applicability Assessment MPR 7123.1 compliance assessment. Request delegation to the STO Manager and STO Chief Engineer.	
MSFC Derived	28.8	Type 4 activities shall also report the results of the Technical Review and Systems Engineering Applicability Assessments to the Associate Director, Technical and the Center Director, who may choose to impose additional systems engineering requirements as determined appropriate based on the particular characteristics of that activity.	CD	MaGIXS Activity Plan	N/A	MAGIXS is categorized as a Mission Type 5 Activity per guidance provided in MPR 7120.1, Table 3-1.	

- **“Marshall Grazing Incidence X-ray Spectrometer (MaGIXS)”**
  - Very small research investigation at MSFC
    - NASA Research Announcement (NRA) for Research Opportunities in Space and Earth Sciences (ROSES)
  - Study solar coronal heating by measuring the solar spectrum
  - Will fly on a suborbital mission onboard a Sounding Rocket
  - Mission Type 5 Activity
  - Very low cost, low criticality for the Agency and MSFC
  - High acceptable tolerance to risk of failure

## ◆ MSFC's Systems Engineering Policy

- Provide integrated, streamlined set of expectations for programs and projects
- Simplify the task for policy implementers in programs/projects
  - Help them understand the intent and applicability of the policy expectations
  - Help them assess the intent against their own particular project characteristics
  - Provide recommended implementation approaches to stimulate creative thought
  - Develop appropriate justifications for risk-based tailoring requests
  - Promote and facilitate the process of requesting and approving tailoring
- Enable risk-informed decision-making by MSFC governance authorities

## ◆ MSFC Customization Tool

- Integrates all components of MSFC policy implementation approach
- Based on Agency “compliance assessment” process, augmented with MSFC specific capabilities/features to further simplify the process for our projects
- Enables risk-informed decision-making to enhance affordability and efficiencies while maintaining appropriate rigor to ensure mission success.
- Potential to implement policy within an integrated, model-based environment which will significantly empower a thinking, agile, risk-based culture.
- Enable projects and governing authorities to utilize the capabilities of modelling and the associated metadata as they assess and “tailor” policy expectations.